



# RBA: Integrated EEG Stimulation and Recording System for Electrical and Acoustical Stimulation

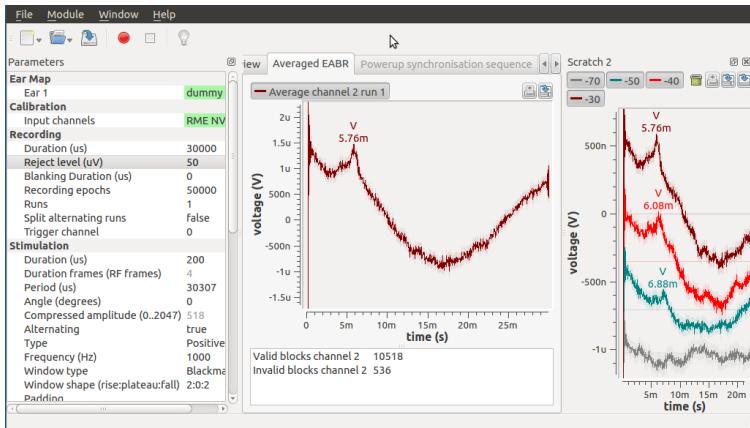
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# Introduction

## Overview: RBA



- Integrated EEG stimulation, recording and analysis for AEP
- Used for all EEG research at ExpORL

# Why not Python/MATLAB/Presentation/...



(Randall Munroe, xkcd 927)

# Why not Python/MATLAB/Presentation/...

- One software platform for all EEG research
  - Avoid to reimplement the wheel
- Open source, free software
- Normally no programming required
- Provide the boring parts:
  - Management of experiments, stimulation and recording
  - Interactive specification of parameters, e. g. amplitude, frequency
  - On-line display of results in plots and tables

# Features: Stimulation

- Acoustic stimulation
  - Internal or external sound card
  - 8 channels for two ears and external triggers
- Electrical stimulation
  - Cochlear NIC and Advanced Bionics BEDCS
- Calibration
  - Graphical interface
- Patient thresholds and fitting
  - Protect against overstimulation
  - Profiles per subject and task

# Features: Recording and Analysis

## Recording

- Multi-channel medical preamplifier connected to sound card
- External trigger

## Analysis

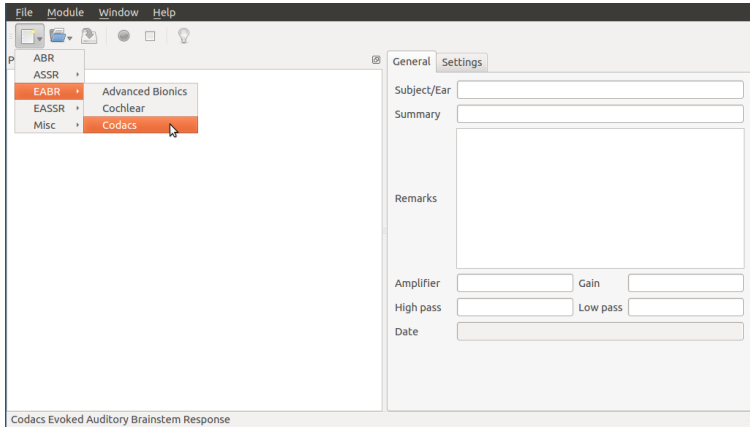
- Analysis: filtering → artifact rejection → averaging
- Reanalysis with different parameters: artifact rejection, ...

## Display

- Preview of stimulus
- On-line results: response shape, spectrum, statistics
- Interactive display and annotation of multiple responses

# Example

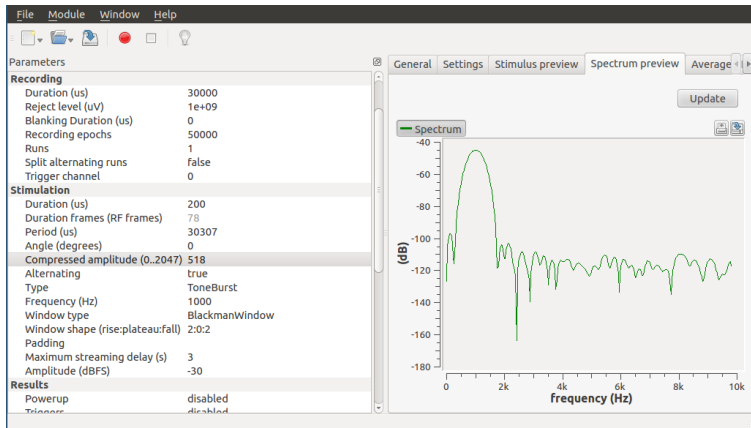
## Prepare experiments



- Select module for paradigm

# Example

## Prepare experiments

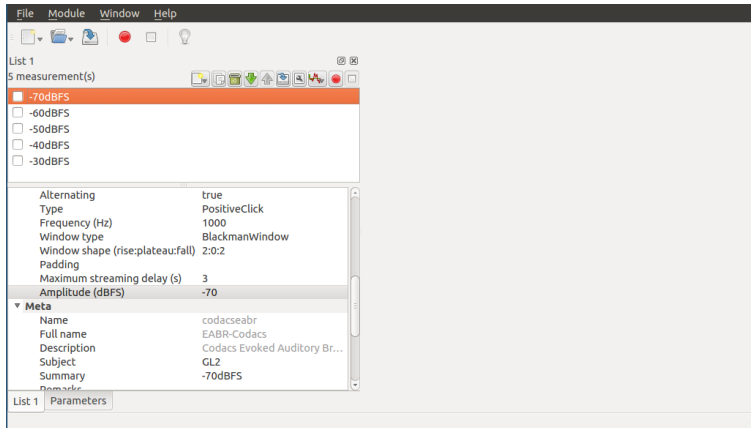


- Select module for paradigm
- Configure experiment parameters



## Example

# Prepare complete sessions



- Automatic recording of multiple successive experiments
- Preparation of additional experiments during ongoing recording

# Calibration, hearing thresholds and CI fitting

Select a calibration profile, specify the target amplitude that should be calibrated and press start. Enter the measured amplitude for the current output amplitude and let the program calculate the correct output parameter automatically until measured and target amplitude are the same.

## Calibration

Calibration profile

RME NV

Manage...

Database status

Not calibrated

Target amplitude (dB)

90

Output parameter

0.5

## Automatic Calibration

Measured amplitude (dB)

92

Correct output parameter

Start

Stop

Advanced...

Remove Calibration

Cancel

Save

# Calibration, hearing thresholds and CI fitting

Select a mapping profile, set an initial stimulation level and begin stimulating. Increase the stimulation level until the patient can hear something, then use this as threshold level. Go on until it is too loud, use this as comfort level.

**Mapping**

Mapping profile  Manage...

Database status Calibrated

**Stimulation**

Current stimulation level

**Threshold and Comfort Levels**

Threshold level  Use current level

Comfort level  Use current level

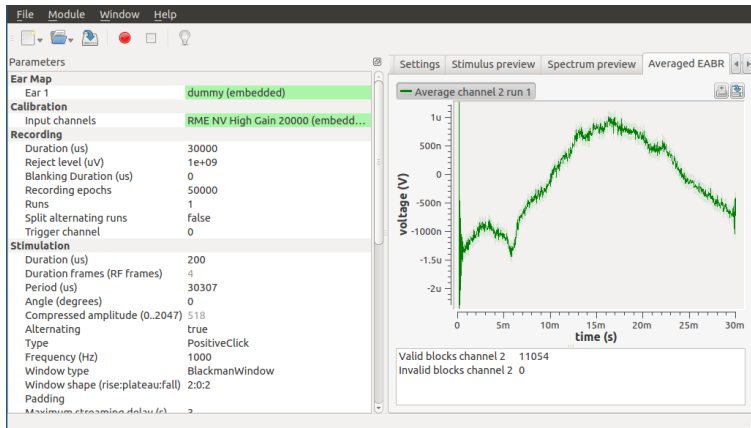
**Calibration Details**

activeElectrode	CI_ELECTRODE_IC1
phaseGap	8
phaseWidth	25
referenceElectrode	CI_ELECTRODE_EC1
stimulationRate	500
type	CathodicFirstPulses

Start Stop Remove Ear Mapping Cancel Save

# Example

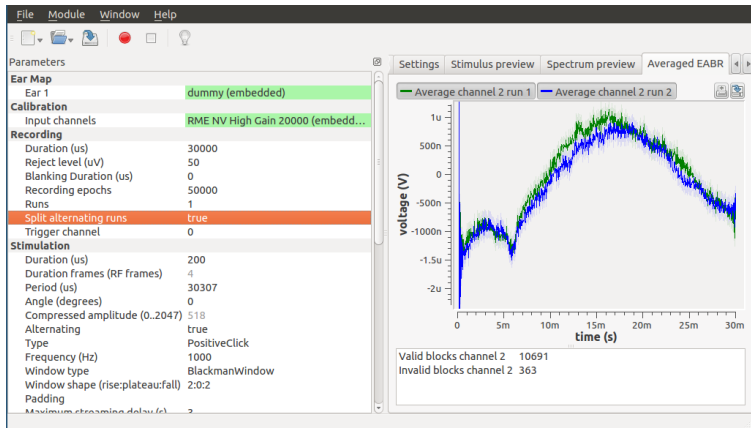
## Recording and analysis



- On-line analysis

# Example

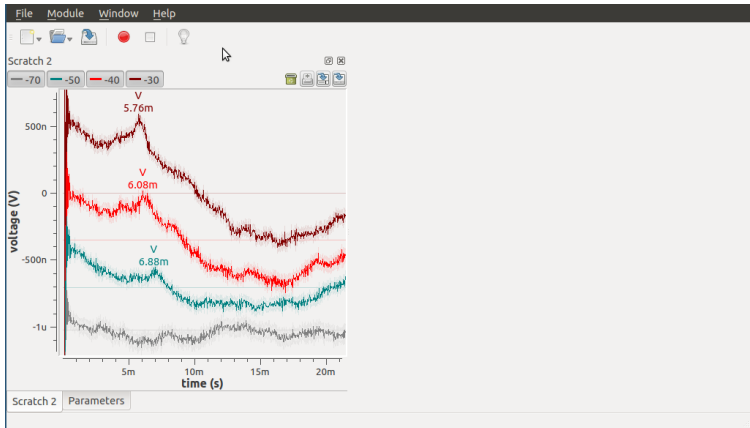
## Recording and analysis



- On-line analysis
- Ad-hoc parameter changes

# Example

## Post-processing



- Compare and annotate

## Data storage

- Recorded EEG: wave files
- Meta data: XML-in-ZIP

000/	- first experiment
meta.xml	- sample rate
calibrations.xml	- 80dB ~ gain 0.5
stimulation.xml	- 40 Hz click train
recording.xml	- 5% artifact rejection
recording.wav	- EEG data
001/	- more experiments
...	

## Export and post-processing

- MATLAB toolbox to read EEG and meta data

```
s = biopil_raw_data('FileName', 'test.rbadata');  
s = biopil_rba_data(s);  
s = biopil_epochs(s);
```



## Export and post-processing

- MATLAB toolbox to read EEG and meta data

```
s = biopil_raw_data('FileName', 'test.rbadata');  
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s = biopil_epochs(s);
```

```
disp(s.RbaData.EpochLength)  
disp(s.RbaData.StimulationFrequency)  
  
plot(mean(s.Epochs.EegData, 2))
```

# Summary and Conclusions

- Stimulation, recording, analysis
- Modules for most common tasks: (E)ABR, (E)ASSR, ...
- Requirements:
  - Linux, Microsoft Windows
  - EEG preamplifier
- Binaries and source code available under the GPL
  - under the condition of a research cooperation
- Paper in preparation